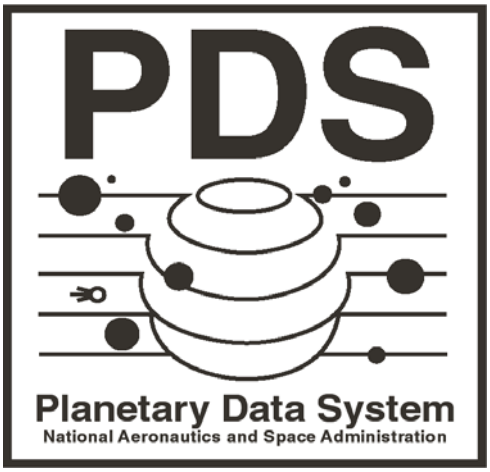
Planetary Data System

Validation Tool Requirements

July 25, 2006

Version 1.3



Jet Propulsion Laboratory
Pasadena, California

CHANGE LOG

Revision	Date	Description	Author
Version 1.0	Nov 10, 2005	Gleaned from an initial set of requirements provided by S. Hughes and combined with input from the Tool Survey.	S. Hughes, R. Joyner, S. Hardman
Version 1.1	Jan 09, 2006	Incorporated comments and focused the document strictly on validation. Also included Level 4 requirements for traceability.	S. Hardman
Version 1.2	Apr 01, 2006	Added the RFA Liens table. Incorporated actions from the “Addressed” RFAs listed in the RFA Liens table. Updated the Applicable Documents section to reference the new version of the Standards Reference document.	S. Hardman
Version 1.3	Jul 25, 2006	Incorporated actions from the “Addressed” RFAs listed in the RFA Liens table. Updated the Applicable Documents section to reference the newly approved level 1, 2 and 3 requirements. Additional modifications were made corresponding to action items that resulted from the Status and Preliminary Design teleconference held on June 1, 2006.	S. Hardman

RFA LIENS

The following table details the RFA liens against this document. The RFAs were generated as a result of the Validation Tool Requirements Review held on February 23, 2006, covering version 1.1 of this document. Additional RFAs were generated on version 1.2 of the document as well.

Status	Count	RFA Number(s)
Open	16	DT01, DT02, LH02, MC02, RAS09, RAS10, RAS11, SS03, SS04, SS05, SS16, SS17, SS18, TK11, TK26, TK27
Tabled	3	RAS01, SS11, SS22
Addressed	39	AR01, AR02, DT03, DT04, JSH01, MC01, MG01, MG02, RAS02, RAS08, RAS16, SS02, SS08, SS10, SS12, SS14, SS15, SS20, TK03, TK04, TK05, TK07, TK09, TK12, TK13, TK14, TK17, TK18, TK19, TK20, TK21, TK22, TK23, TK24, TK25, TK28, TK29, TK30, TK31

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide requirements for the next generation Planetary Data System (PDS) Validation Tool. The Discipline Nodes, Engineering Node and the PDS user community as a whole utilize the current generation of tools (e.g. lvtool, kwvtool, tbtool and table_check) for validation of PDS product labels and products. This document will capture the requirements for the current generation as well as requirements representing new functionality for the next generation.

1.2 Scope

The scope of this document specifically focuses on PDS label and product validation, as directed by the PDS Management Council on October 5, 2005 at the Management Council face-to-face meeting. This document will be extended to cover other aspects of validation (e.g. catalog, volume and data set validation) per the direction of the PDS Management Council as future efforts are prioritized relative to tool development.

1.3 Notation

The numbering of the requirements in this document will be formatted as **LX.VAL.XX.X**, where:

- **LX** represents the requirements level where X is a number.
- **VAL** is an acronym representing validation requirements section for the specified level.
- **XX** represents the type of requirement, either **FR** for functional or **NF** for non-functional.
- **X** is a unique number for the type of requirement.

Following the text of a requirement may be a reference to the requirement from which it was derived. The reference will be in parenthesis.

A paragraph following a requirement, which is indented and has a reduced font size, represents a comment providing additional insight for the requirement that it follows. This comment should not be considered part of the requirement for development or testing purposes.

1.4 Audience

This document is written primarily for those who will use the requirements to design, implement and test the next generation validation tool as well as for those who will build discipline specific applications utilizing such a tool as a component. The expected audience includes:

- PDS EN Development Staff
- PDS Node Technical Staff

1.5 Controlling Documents

[1] Planetary Data System (PDS) Level 1, 2 and 3 Requirements, May 26, 2006.

1.6 Applicable Documents

[2] Planetary Data System (PDS) Standards Reference, March 20, 2006, Version 3.7, JPL D-7669, Part 2.

[3] Planetary Science Data Dictionary Document, August 28, 2002, Planetary Data System (PDS), JPL D-7116, Rev E.

1.7 Other References

[4] Tools Survey, April 2005.

1.8 Document Maintenance

It is anticipated that additional phases of development will be defined and approved by the Management Council resulting in modifications to this document. This document and the requirements specified herein will be kept under configuration control with any modifications submitted to the Management Council for approval.

2.0 LEVEL 4 REQUIREMENTS

This section details the level 4 functional requirements for the Validation Tool. These requirements are derived directly from the level 3 requirements [1].

L4.VAL.FR.1 - The Tool shall assist users in determining whether a PDS data product is compliant with the PDS Standards. (1.5.2)

> As defined in chapter 4 of the PDS Standards Reference [2], a data product consists of a PDS label and the data object(s) that it describes. PDS labels describe the content and format of a data product. PDS labels are represented in Object Description Language (ODL). Data objects are the actual data for which the structure and attributes are defined in a PDS label. Examples of data objects include tables, spreadsheets, images, etc.

L4.VAL.FR.2 - The Tool shall generate a report detailing the results of validation. (1.5.2)

L4.VAL.FR.3 - The Tool shall provide documentation detailing its installation and use. (1.5.4)

3.0 LEVEL 5 REQUIREMENTS

This section details the level 5 requirements for the Validation Tool. These requirements have been broken up into functional and non-functional requirements. The functional requirements are derived directly from the level 4 requirements above. The non-functional requirements are derived from the level 4 requirements and other sources as well, including the *Tools Survey* [4] and existing capabilities from the current generation of tools.

3.1 Functional Requirements

The functional validation requirements define the methods by which the Validation Tool will programmatically ascertain if a given data product is PDS compliant (or "valid"). Typically, this means the data product is well formed, complete, syntactically and semantically correct, and that it conforms to all applicable PDS standards. The standards themselves are defined in the *PDS Standards Reference* [2]. This document makes every effort to refer to the Standards Reference where appropriate instead of reiterating the content of that document.

Also note that validation does not ensure that a data product is scientifically accurate or useful to the planetary science community. Those issues are decided through the peer review process.

3.1.1 General Requirements

The requirements in this section pertain to the identification and specification of PDS data products to be validated by the tool.

L5.VAL.FR.21 - The Tool shall be able to validate one or more PDS data products as the result of a single tool execution. (L4.VAL.FR.1)

L5.VAL.FR.29 - The Tool shall be able to validate all PDS data products in a directory. (L4.VAL.FR.1)

L5.VAL.FR.30 - The Tool shall be able to traverse a directory tree and recursively validate the content of all directories. (L4.VAL.FR.1)

L5.VAL.FR.22 - The Tool shall be able to validate a PDS data product that has been constructed with one of the following methods: (L4.VAL.FR.1)

a) Attached Label
b) Detached Label
c) Combined Detached Label

A definition and examples of each of the above methods can be found in chapters 4 and 5 [2].

L5.VAL.FR.23 - The Tool shall be able to merge the contents of label fragments referenced by ^STRUCTURE pointers with the contents of the parent label when validating a PDS label. (L4.VAL.FR.1)

L5.VAL.FR.27 - The Tool shall validate a PDS label fragment as it would a PDS label with the following exceptions: (L4.VAL.FR.1)

a) An SFDU label must not be contained in the label fragment.
b) A PDS_VERSION_ID statement must not be contained in the label fragment.
c) File characteristic elements must not be contained in the label fragment.
d) An END statement must not be contained in the label fragment.

L5.VAL.FR.28 - The Tool shall identify files having an extension of FMT as a PDS label fragment. (L4.VAL.FR.1)

L5.VAL.FR.32 - The Tool shall accept the following as input for specifying the data product(s) to be validated:

a) File Specification(s)
b) Directory Specification(s)
c) Uniform Resource Locator(s) (URL)

A URL allows access to a data product from a local disk or a remote machine.

L5.VAL.FR.33 - The Tool shall accept the following as input for specifying the instance(s) of the PSDD to be used for validation:

a) File Specification(s)
b) Uniform Resource Locator(s) (URL)

3.1.2 Syntactic Validation Requirements

The requirements in this section pertain to validation of the PDS label portion of the data product. Syntactic validation ensures the grammar of the PDS label is compliant (i.e., the grammar used in labels conforms to the ODL specification, as adopted by the PDS). Chapter 12 of the *PDS Standards Reference* [2] provides a complete specification for Object Description Language (ODL), the language used to encode PDS labels. This chapter contains a formal definition of the ODL grammar along with PDS specific extensions and constraints. Additional extensions and constraints on ODL can also be found in chapters 5 and 7 [2].

L5.VAL.FR.1 - The Tool shall syntactically validate a PDS label as specified in chapter 12 of the *PDS Standards Reference* [2]. (L4.VAL.FR.1)

As noted in chapter 12 [2], syntactic validation of PDS labels is limited to the PDS specific implementation of the ODL specification.

L5.VAL.FR.24 - The Tool shall verify that the characters in a PDS label are constrained to a limited subset of the standard 7-bit ASCII character set as follows: (L4.VAL.FR.1)

a) All characters in the range of 32 through 126 (decimal).
b) The line feed character (10 decimal).
c) The carriage return character (13 decimal).

The remaining 7-bit ASCII characters (1-9, 11, 12, 14-31 and 127 decimal, which includes the horizontal and vertical tab and form feed characters) are not permitted in PDS labels. This requirement is derived from section 5.1.2 [2].

L5.VAL.FR.25 - The Tool shall verify that all lines in a PDS label are terminated with a carriage return character followed by a line feed character. (L4.VAL.FR.1.1)

This requirement is derived from section 5.1.2 [2].

L5.VAL.FR.34 - The Tool shall verify that a date/time value in a PDS label is valid as specified in chapter 7 of the *PDS Standards Reference* [2]. (L4.VAL.FR.1)

3.1.3 Semantic Validation Requirements

The requirements in this section pertain to validation of the PDS label portion of the data product. Semantic validation governs ensuring the structure of the PDS label is compliant (i.e., the structure of the objects, groups, keywords, and keyword-values, used in labels, conforms to the Planetary Science Data Dictionary (PSDD) specification). The PSDD is described in the *Planetary Science Data Dictionary Document* [3].

L5.VAL.FR.2 - The Tool shall semantically validate a PDS label according to the constructs as specified in one or more PDS compliant data dictionaries. (L4.VAL.FR.1)

L5.VAL.FR.2.1 - The Tool shall verify that all objects in the PDS label exist as specified in one or more PDS compliant data dictionaries.

L5.VAL.FR.2.2 - The Tool shall verify that all elements in the PDS label exist as specified in one or more PDS compliant data dictionaries.

L5.VAL.FR.2.3 - The Tool shall verify that all element values are valid as specified as specified in one or more PDS compliant data dictionaries, including:

a) That all element values are consistent with the specified element value type.
b) That the length of all non-numeric element values is within the specified length limit.

c) That all element values constrained by enumerated lists (STATIC and DYNAMIC) are allowed values.
d) That all numeric element values are within the specified range.

L5.VAL.FR.2.4 - The Tool shall verify that all required objects and elements as specified in the PSDD, exist in the PDS label.

L5.VAL.FR.3 - The Tool shall verify that a data object exists when referenced by a pointer in the PDS label. (L4.VAL.FR.1)

L5.VAL.FR.19 - The Tool shall verify that a file exists when referenced by a pointer in the PDS label. (L4.VAL.FR.1)

L5.VAL.FR.4 - [Deleted]

L5.VAL.FR.26 - The Tool shall validate the following with respect to a Standard Formatted Data Unit (SFDU) present in a PDS label, as specified in chapter 16 of the PDS Standards Reference [2]: (L4.VAL.FR.1)

a) The length of each SFDU label is correct.
b) The location of each SFDU, within a PDS label is correct.
c) The Control Authority ID is valid for the given SFDU label class.
d) The Version ID is valid.
e) The Class ID is valid.
f) The Delimiter Type is valid.
g) The start marker in a K class SFDU label has an identical end marker.

L5.VAL.FR.38 - The Tool shall report the existence of a Standard Formatted Data Unit (SFDU), if encountered in a PDS label.

L5.VAL.FR.35 - The Tool shall verify that the PDS_VERSION_ID element is either: (L4.VAL.FR.1)

a) The first line of a PDS label, if an SFDU is not present in the label.
b) The second line of a PDS label, if an SFDU is present in the label.

This requirement is derived from section 5.3.1 [2].

L5.VAL.FR.36 - The Tool shall verify that a PDS label contains the appropriate file characteristic elements as specified in section 5.3.2 of the *PDS Standards Reference* [2]. (L4.VAL.FR.1)

The file characteristic elements include RECORD_TYPE, RECORD_BYTES, FILE_RECORDS and LABEL_RECORDS.

L5.VAL.FR.37 - The Tool shall verify that a PDS label is properly padded as specified in section 5.1.2 of the *PDS Standards Reference* [2]. (L4.VAL.FR.1)

3.1.4 Content Validation Requirements

Content validation governs ensuring that the PDS label accurately describes the data object (i.e., the objects, groups, keywords, and keyword-values in the description accurately describe the structure used within the data object).

L5.VAL.FR.5 - [Deleted]

L5.VAL.FR.6 - [Deleted]

L5.VAL.FR.7 - [Deleted]

L5.VAL.FR.8 - [Deleted]

Content validation for specific data object types will be limited to the Primary Data Objects (e.g. TABLE, SPREADSHEET and IMAGE) as defined in chapter 4 of the *PDS Standards Reference* [2].

L5.VAL.FR.9 - The Tool shall be able to validate that data objects of type TABLE are accurately described by the PDS label, including: (L4.VAL.FR.1)

a) The referenced data object contains the correct number of columns and rows.
b) The data object has the correct record_bytes and row_bytes.
c) The data object has the correct record_type and interchange_format.
d) The data object has the correct number of total bytes (as calculated from record_bytes and row_bytes).
e) The data_type of each column is correct.
f) The number of bytes in each column is correct.
g) The value ranges, if specified, for each column are correct.
h) Invalid ASCII character in column of type CHARACTER.
i) Record is not properly delimited.
j) 'E' format field does not have an exponent.
k) 'F' format field decimal point does not align with precision value.
l) 'I' format field is not right justified.
m) The column contains a malformed DATE or TIME format.

> The interchange_format, ASCII or BINARY, will determine the extent to which the table can be validated. Validation of a BINARY table is more restricted. A definition of the TABLE data object can be found in Appendix A, section 28 of the *PDS Standards Reference* [2].

L5.VAL.FR.10 - The Tool shall be able to validate that data objects of type SPREADSHEET are accurately described by the PDS label, including: (L4.VAL.FR.1)

a) The referenced data object contains the correct number of fields and rows.
b) The data object has the correct record_bytes and row_bytes.
c) The data object has the correct record_type and interchange_format.
d) The data_type of each field is correct.
e) The number of bytes in each field is correct.

f) The value ranges, if specified, for each field are correct.
g) The field_delimiter correctly delimits each field.
h) The value ranges, if specified, for each field are correct.
i) Invalid ASCII character in column of type CHARACTER.
j) Record is not properly delimited.
k) 'E' format field does not have an exponent.
l) 'F' format field decimal point does not align with precision value.
m) 'I' format field is not right justified.
n) The column contains a malformed DATE or TIME format.

A definition of the SPREADSHEET data object can be found in Appendix A, section 27 of the *PDS Standards Reference* [2].

L5.VAL.FR.11 - The Tool shall be able to validate that data objects of type IMAGE are accurately described by the PDS label, including: (L4.VAL.FR.1)

a) The referenced data object has the correct number of total bytes (as calculated from line_samples, sample_bits, line_prefix_bytes, line_suffix_bytes, lines, and bands).
b) The mean, standard_deviation, maximum, and minimum values are correct (if supplied).

A definition of the IMAGE data object can be found in Appendix A, section 20 of the *PDS Standards Reference* [2].

3.1.5 Reporting Requirements

The requirements in this section pertain to reporting the results of validation.

L5.VAL.FR.12 - The Tool shall be capable of reporting the following with regard to a validation anomaly: (L4.VAL.FR.2)

a) The location of the anomaly.
b) The content of the line triggering the anomaly.
c) Severity level of the anomaly (e.g., information, warning, or error).
d) Textual description of the anomaly.

L5.VAL.FR.18 - The Tool shall be capable of reporting the results of validation in a human-readable format. (L4.VAL.FR.2)

L5.VAL.FR.13 - The Tool shall be capable of reporting the results of validation in a software-readable format. (L4.VAL.FR.2)

An example of a software-readable format would be a structure represented in XML.

L5.VAL.FR.14 - The Tool shall be capable of generating validation reports with the following level of detail: (L4.VAL.FR.2)

a) Minimal – where only the number of anomalies detected are reported; grouped by severity level.

b) Summary – where the set of detected anomalies are summarized by reporting the number of occurrences for each type of anomaly and providing the location of one example for that anomaly.
c) Verbose – where the location, severity, and textual description of each detected anomaly are reported.

Once a validation report is in a software-readable format, any of the above representations can be generated from the original report.

L5.VAL.FR.15 - [Deleted]

L5.VAL.FR.20 - The Tool shall include the following information in a validation report: (L4.VAL.FR.2)
a) The version of the tool.
b) The date and time of the execution of the tool.
c) The values for all configurable parameters.

L5.VAL.FR.16 - [Deleted]

L5.VAL.FR.17 - [Deleted]

L5.VAL.FR.31 - The Tool shall return an exit status to the calling application.

The calling application could be a program utilizing the API or a script executing the tool via the command-line.

3.2 Non-Functional Requirements

The non-functional requirements cover interface, compatibility and documentation aspects for the Validation Tool.

3.2.1 Interface Requirements

Interface requirements address the interaction between the tools and users of the tools.

L5.VAL.NF.1 - The Tool shall be accessible through an Application Programming Interface (API).

A component-based implementation allows the validation capabilities to be incorporated and utilized in a consistent manner by other applications.

L5.VAL.NF.2 - The Tool shall have the capability to be executed from a command-line interface.

L5.VAL.NF.3 - [Deleted]

L5.VAL.NF.4 - [Deleted]

L5.VAL.NF.5 - [Deleted]

L5.VAL.NF.6 - The Tool shall provide configurable parameters for controlling functional behavior, which can be supplied to the tool in the following methods:

a) Supplied as command-line options.
b) Supplied in the form of a configuration file.

L5.VAL.NF.7 - [Deleted]

L5.VAL.NF.11 - The Tool shall be capable of delivering the validation report in the following methods: (L4.VAL.FR.2)

a) To the terminal's standard output stream.
b) To a specified file.

3.2.2 Compatibility Requirements

Compatibility requirements address the manner in which the tools must be able to interoperate in a heterogeneous computing environment.

L5.VAL.NF.8 - The Tool shall run on any PDS-supported platform.

> The list of PDS-supported platforms will be specified in a higher-level requirement from which this requirement will be derived.

3.2.3 Documentation Requirements

Documentation requirements address the documentation needed to support tool interfacing and execution.

L5.VAL.NF.9 - The Tool shall provide documentation for the Application Programming Interface (API). (L4.VAL.FR.3)

L5.VAL.NF.10 - The Tool shall provide documentation for the use of the tools. (L4.VAL.FR.3)

APPENDIX A ACRONYMS

Acronyms pertaining to this document:

API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
EN	Engineering Node (PDS)
JPL	Jet Propulsion Laboratory
NASA	National Aeronautics and Space Administration
ODL	Object Description Language
PDS	Planetary Data System
PSDD	Planetary Science Data Dictionary
SFDU	Standard Formatted Data Unit
URL	Uniform Resource Locator
XML	Extensible Markup Language

APPENDIX B TRACEABILITY MATRIX

The traceability matrix maps the level 5 requirements for the Validation Tool in this document to the source from which they were derived. The functional requirements are derived directly from the level 4 requirements found in this document. The non-functional requirements are derived from the level 4 requirements and other sources as well, including the *Tools Survey* [4] and existing capabilities from the current generation of tools.

Requirement	Derived From	Legacy Tool(s)
L5.VAL.FR.1	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.2	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.3	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.4 [Deleted]	N/A	N/A
L5.VAL.FR.5 [Deleted]	N/A	N/A
L5.VAL.FR.6 [Deleted]	N/A	N/A
L5.VAL.FR.7 [Deleted]	N/A	N/A
L5.VAL.FR.8 [Deleted]	N/A	N/A
L5.VAL.FR.9	L4.VAL.FR.1	tbtool, table_check
L5.VAL.FR.10	L4.VAL.FR.1	N/A
L5.VAL.FR.11	L4.VAL.FR.1	N/A
L5.VAL.FR.12	L4.VAL.FR.2	lvtool, PVT
L5.VAL.FR.13	L4.VAL.FR.2	N/A
L5.VAL.FR.14	L4.VAL.FR.2	lvtool, PVT
L5.VAL.FR.15 [Deleted]	N/A	N/A
L5.VAL.FR.16	L4.VAL.FR.2	kwvtool
L5.VAL.FR.17	L4.VAL.FR.2	ddict
L5.VAL.FR.18	L4.VAL.FR.2	All tools
L5.VAL.FR.19	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.20	L4.VAL.FR.2	All tools
L5.VAL.FR.21	L4.VAL.FR.1	All tools
L5.VAL.FR.22	L4.VAL.FR.1	All tools (partial)
L5.VAL.FR.23	L4.VAL.FR.1	All tools
L5.VAL.FR.24	L4.VAL.FR.1	lvtool, PVT (partial)
L5.VAL.FR.25 [Deleted]	N/A	N/A
L5.VAL.FR.26	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.27	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.28	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.29	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.30	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.31	Existing Capability	All tools
L5.VAL.FR.32	Existing Capability	All tools (partial)
L5.VAL.FR.33	Existing Capability	All tools (partial)
L5.VAL.FR.34	L4.VAL.FR.1	lvtool, PVT
L5.VAL.FR.35	L4.VAL.FR.1	N/A

Requirement	Derived From	Legacy Tool(s)
L5.VAL.FR.36	L4.VAL.FR.1	N/A
L5.VAL.FR.37	L4.VAL.FR.1	N/A
L5.VAL.FR.38	L4.VAL.FR.1	N/A
L5.VAL.NF.1	Tools Survey	PVT
L5.VAL.NF.2	Existing Capability	All tools
L5.VAL.NF.3 [Deleted]	N/A	N/A
L5.VAL.NF.4 [Deleted]	N/A	N/A
L5.VAL.NF.5 [Deleted]	N/A	N/A
L5.VAL.NF.6	Existing Capability	All tools
L5.VAL.NF.7 [Deleted]	N/A	N/A
L5.VAL.NF.8	Existing Capability	All tools (excluding Mac OS X)
L5.VAL.NF.9	L4.VAL.FR.3	PVT
L5.VAL.NF.10	L4.VAL.FR.3	All tools
L5.VAL.NF.11	L4.VAL.FR.2	All tools (partial)